

The Hug: An Exploration of Robotic Form For Intimate Communication

Carl DiSalvo¹, Francine Gemperle², Jodi Forlizzi^{1,3}, Elliott Montgomery¹

School of Design¹, Institute for Complex Engineered Systems²,

Human-Computer Interaction Institute³

Carnegie Mellon University

Pittsburgh, PA, USA

{cdisalvo | fg24 | forlizzi | epm}@andrew.cmu.edu

Abstract

As advances in robotics create robust technology capable of being deployed in the home, design serves an important role shaping how robots will be experienced in accessible, appropriate, and compelling manners. The designer's task of shaping technology is fundamentally concerned with the creation of form. Form is the total expression of a product, including physical shape, materials, and behavioral qualities. In creating form, design balances the needs of people, the capabilities of technology, and the context of use to support an activity or action. In this paper we present The Hug, a conceptual design exploration of form for a robotic product that facilitates intimate communication across distance. We discuss the role of form in constructing meaningful relationships through The Hug and other robotic products.

1. Introduction

A challenge in the research and development of robotic products, particularly those intended for human service and interaction, is ascertaining what forms and qualities of form will be most effective in creating meaningful experiences. Motivated by a desire to contribute design knowledge to this challenge, we created The Hug – a conceptual design for a robotic product that facilitates intimate communication across distance (Figure 1). Emphasizing the physical aspects of communication, The Hug uses expressive anthropomorphic form to impart a sense of presence and relies on touch and voice for interaction and control. The Hug exists as both a research platform for human-robot interaction and a demonstration of the potential for a design driven approach to the development human-centered robotic products.

Our decision to design The Hug was informed by our research on the experience of aging [3,7]. One of the findings from our research is a pronounced need for more accessible, appropriate, and compelling communication products for the aging population. Maintaining social and emotional bonds through intimate communication is an essential human activity and characteristic of healthy family life. In our contemporary culture extended families (i.e., grandparents and their children and grandchildren) often do not live together, reducing the opportunity



Figure 1. The Hug.

and ability to regularly engage in intimate communication. Communication products such as the phone and email are used regularly, but tend not to support intimate communication because intimate communication is generally rich, involving physical interaction and multiple senses. Intimate communication is not only pleasurable, it is also profoundly important for maintaining mental, emotional, and physical health. The design of The Hug explores how current robotic technology can be used to facilitates intimate communication across distance.

2. A Scenario of Use

To understand how The Hug facilitates intimate communication across distance consider these scenarios.

Mary lives in Chicago and her granddaughter, Chrissy, lives in Pittsburgh. They use The Hug to stay connected. One evening while sitting in her living room Mary hears her Hug's melody and sees a warm glow in its belly, signalling that someone is sending her a hug. She picks up her Hug, squeezes its left paw and says "Hello."

She hears her granddaughter Chrissy respond “Hello Grandma.” As Mary and Chrissy chat, Mary strokes the back of her Hug, causing Chrissy’s Hug to vibrate softly (Figure 2). As time passes, their Hugs begin to slowly warm, radiating a comfortable heat. Once they are done chatting, Mary says goodbye, and squeezes her Hug’s right paw. The Hug plays another melody and glows, signalling that this hug has ended.

It is also possible to leave a Hug message.

On Chrissy’s birthday, Mary decides to send her granddaughter a hug, but Chrissy is not home. The melody and glow on Mary’s Hug change from “ringing” to “no one at home”. Mary decides to leave Chrissy a Hug message. She squeezes the left paw again and says “Leave a message”. Mary strokes the back of her Hug to generate a unique vibration pattern and records a voice note. Later in the evening, Chrissy comes home and sees a light flashing on her Hug, signalling a message is waiting. Chrissy picks up The Hug and plays back the message. She hears her Grandma’s birthday greeting and feels her unique vibration pattern.

3. The Form of Intimate Communication

The colloquial use of the word “form” emphasizes the physical shape of an object. Design approaches form as the total expression of the product, not just how something appears, but the whole experience of the interacting with the product. Form includes a product’s physical shape, materials, and behavioral qualities. Designers use form to balance the needs of people, the capabilities of technology, and the context of use into a single product. Interaction design specifically approaches form in relation to supporting an activity or action. The form of The Hug is inspired by a study of activities and actions associated with intimate communication.

In our early ideation we explored the general category of communication, focusing on intimate communication as an unmet need and opportunity for a novel form. We were particularly interested in the role of the senses and the body in intimate communication. We studied images of people engaged in intimate communication to understand the physical language involved. We collected existing products, shapes, and materials that suggested the qualities of intimate communication. These activities of reflective and contextual research provided us with a catalogue of tacit knowledge to draw from in our design.

The Hug is preceded by a large body of work exploring intimate communication and telepresence within design [8,11,17], computer-mediated communication [10], and robotics [4,13,15,18]. More broadly, our interaction design builds on research in tangible and ubiquitous computing [1,9,19], ambient displays [2,5,6,14], social computing [16], technologies for aging in place [12], and the history of anthropomorphic form in product design. The Hug is a novel design that integrates the research from



Figure 2. An example of The Hug in use.

these diverse fields a single product form focusing on the holistic experience of use.

In the next section, we describe the form of The Hug through its physical shape, materials, behavioural qualities, and how the product works as part of a system.

a. Physical Shape

The physical shape of The Hug expresses the gesture of hugging. We have designed an anthropomorphic form with two arms reaching slightly up and out from a stout torso. The Hug body has rounded shapes suggesting a head and two feet. The form accepts the human body naturally and instructs the user how to interact with the product. When resting in its base or on a couch, The Hug reaches upward and outward, a gesture that begs for a hug. When cradled or hugged in the arms of the user, the curved form fits naturally with the human body, creating a comfortable fit. When held in the lap, The Hug rests either facing forward towards the upper torso or backwards sitting in the lap (Figures 2-4). The scale of The Hug is similar to a pillow, creating a familiar relationship with the body and facilitating a number of alternate locations for holding, hugging and resting on The Hug. The base is shaped like a seat, creating a place for the robot in the home.

b. Materials

The Hug is covered with velour and silk upholstered fabrics that are familiar and fit the home context. The Hug does not look “out of place” on a couch or a bed. The surface materials of the Hug also support interaction. The textiles were specifically chosen to encourage intimate touch in the form of petting; they are smooth and distinctive. Most importantly, The Hug is soft, allowing it

to be firmly embraced and molding to comfortably fit a range of body shapes and postures for cuddling.

b. Behavioural Qualities (Interaction and Expression)

The Hug uses physical interaction and several sensory cues to create the experience of rich communication. Communication is initiated by squeezing the left paw, and speaking the receiver's name into the microphone. To accept an incoming Hug, the receiver squeezes the left paw of The Hug and says "Hello", opening a direct voice channel between the two Hugs. The status of The Hug communication is expressed through light embedded in the belly and a selection of sounds. In the belly, a circular electroluminescent light source fluctuates in color and intensity. The sounds are customizable multi-tonal melodies, emphasizing the personal nature of the communication. These signals are used in conjunction to express an "incoming hug", "no one at home", and "goodbye".

Once a connection is established, senders can squeeze, stroke, or pet The Hug, activating sensors inside. Touch sensors in the back of The Hug capture rubbing and stroking motions. These motions are transmitted from one Hug to another and mapped to motors on the front of the receiving Hug, creating unique vibration patterns in its arms and belly. Thermal fibers around the belly of the hug produce a comfortable radiating warmth that slowly increases with time as The Hug is used. Communication is terminated by squeezing the right paw and saying "Goodbye".

If a Hug connection is not established, a Hug message containing voice, vibration and heat patterns can

be left and received later. Up to four hugs can be stored in a queue.

c. The Hug Network + Base

The Hug is designed for person-to-person communication. The base station is used for storage, battery recharge, and setting up a Hug network. The network of callers is closed, and contains a finite number of callers specified by a user. A Hug network is set up using memory cards with unique addresses. Introducing a new Hug into a Hug network requires sharing a memory card and correlating it to a voice tag for the name of the person the Hug card connects to.

This network setup ensures privacy and control for the user. Only the person who sets up the Hug network has access to the other Hugs on the network. This setup supports intimate communication, prevents prank Hugs or wrong Hug connections, and eliminates any public use of Hug networks.

4. Suggestions for the Design of Robotic Products that Support Intimate Communication.

Robotic product design is an area that will continue to grow as more and more robots are ready to leave the research lab and enter the consumer marketplace. In designing The Hug we have embodied many ideas about communication and interaction design for intimate situations. To summarize, we propose the following design goals for robotic products that support intimate communication.



Figure 4. The Hug being held backwards in the lap.



Figure 5. The Hug being held forwards in the lap.



Figure 6. Images such as this were studied to capture the gesture of hugging and direct the development of form.

Design physical shapes to reference a human gesture associated with a specific form of intimate communication.

These shapes are recognizable, informative, and welcoming; they enhance comfort and ease of use. Referencing a human gesture (for example, a hug, a kiss, or a whisper) allows for an appropriate level of embodiment without reverting to purely representational anthropomorphic form. The outstretched arms of The Hug are the same as the outstretched arms of any person requesting a hug, naturally directing how The Hug is held and used (Figures 4- 6).

Design physical interactions and emotive expressions to reference the qualities and actions of a specific form of intimate communication.

These qualities and actions are intuitive to the activity supported and are what makes intimate communication “rich”. The physical interaction with The Hug references the actions of hugging such as the embrace and stroking the back. The emotive expressions communicated from one Hug to another reference the qualities of a hug, such as the warmth of two living bodies next to one another and the vibration in the chest when speaking (Figures 6 and 7).

Design informative expressions and basic operations to reference existing analogous technologies.

Leveraging the familiarity users have with the everyday products in their homes decreases barriers to adoption and use. People have a tacit knowledge of how everyday

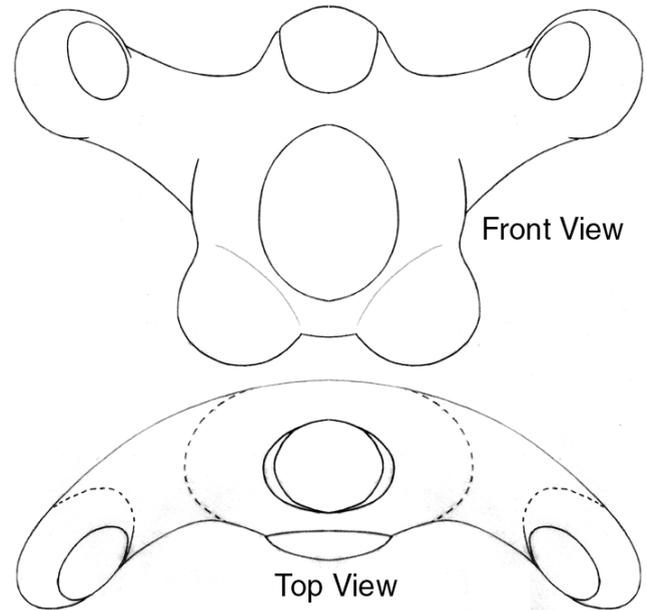


Figure 7. Productions drawings of The Hug reflecting the shape and gesture of a human hug.

products work and a lifetime of experience operating and interacting with them. The Hug builds on a metaphor of telephone calls and answering machines. Hugs are signaled with audio alerts similar to telephone ring tones. Hugs are “answered” and messages can be left.

Design the system to privilege intimate communication over information management.

Managing, organizing, and maintaining data is tedious and often impersonal. Intimate communication requires a sense of trust and peace that may be thwarted if combined with invasive functionality. Designing to support intimate communication must respect the human experience of intimacy and that respect must be reflected in the form and functionality of the product. All of the functionality of The Hug is directed solely at supporting intimate communication and information management tasks have been minimized

5. Conclusion and Future Work – Designing Robotic Products

The work of designers and design researchers shifts the orientation from designing *robots* to designing *robotic products*. This emphasizes the human use and socio-cultural contexts of the technology. The term “robot” carries cultural associations and expectations, which are often inappropriate or unrealistic for the kinds of service robots that may soon exist. The term “product” describes an artifact that people are familiar with, and realistically, the first service robots deployed in the home will most



Figure 8. Interacting with The Hug through squeezing and petting.

likely resemble “smart” versions of existing products rather than science fiction visions of mechanical maids.

Envisioning how *technologies* become *products* is an approach that design research brings to the domain of robotics. Product development differs from visionary product design. Visionary product design requires a holistic approach to the function, shape, materials, and manners of interaction that unifies the parts into a single form facilitating specific activities and actions. This approach is differentiated from others because it does not emphasize any one part (such as manners of interaction) or any one aspect of a part (such as auditory cues). Instead, the emphasis is on the total experience of parts as a single product.

Because The Hug is a visionary product concept, engineers might argue that The Hug has yet to be started. Designers might argue that The Hug is completed. As a visionary product concept, the purpose of The Hug is a demonstration of how design can be utilized to create an innovative form that fosters an accessible, appropriate, and compelling experience with robotics, rather than a demonstration of technology.

However, it is important to emphasize that The Hug is not an unformed design sketch. The functionality of The Hug design concept has foundation in existing and available technology. The Hug’s hardware would include vibrating motors, thermal fibers, lights, and wireless voice communications. Existing software protocols could be used for wireless interaction over the Internet.

There are two directions for ‘next steps’ for The Hug: development as a consumer product and continuation of academic research. Consumer product development will

require an interdisciplinary team to integrate the hardware systems into a single hug form and implement communication software protocols. Additionally, as part of the product development process, further market analysis needs to be done to understand how this product would fit within the myriad of existing communication products available today.

As an academic research initiative The Hug is a valuable platform for investigation issues of human-robot interaction in general, and specifically the design of robotic products to facilitate intimate communication. Such research begins with presenting the concept to potential users and soliciting feedback. To date, a few informal conversations have been conducted with elders and revealed that they disliked the colors (pale green or dark red) and had problems resolving the size of The Hug with the size of a child, wanting it to be either smaller or larger. These conversations pointed toward the design of a Hug “core” with interchangeable or customisable housing that could take different shapes or surface materials. Further conversations with potential users of The Hug are necessary to strengthen the concept and refine the form.

Acknowledgements

This work is funded by NSF IIS-0121426. Thanks to Willy Yonkers, Jamie Divine, Lou Lombardi, Sara Kiesler, and those who evaluated our concept in progress.

References

- [1] Chang, S., O'Modhrain, Jacob, R., Gunther, E., Ishii, H., ComTouch: Design of a Vibrotactile Communication Device, in *Proceedings ACM DIS 2002 Designing Interactive Systems Conference*, 2002.
- [2] Fogarty, J., Forlizzi, J., Hudson, S., Aesthetic Information Collages: Generating Decorative Displays that Contain Information, in *Proceedings of the 14th annual ACM Symposium on User Interface Software and Technology*, 2001.
- [3] Forlizzi, J., Hirsch, T., Hyder, E., Goetz, J. “Designing Pleasurable Technology for Elders.” *INCLUDE, International Conference on Inclusive Design and Communications*, London, England, April 2001.
- [4] Goldberg, K (ed), *The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet*, MIT Press, June, 2000.
- [5] Heiner, J. , Hudson, S., Tanaka, K. The information percolator: ambient information display in a decorative object, in *Proceedings of the 12th Annual*

- [6] Ho-Ching, W., Mankoff, J., Landay, J. "Can you see what I hear? The Design and Evaluation of a Peripheral Sound Display for the Deaf." *Proceedings of the CHI 2003 Conference*, 2003, pp.161-168.
- [7] Hirsch, T., Forlizzi, J., Hyder, E., Goetz, J., Stroback, J., and Kurtz, C. "The ELDeR Project: Social and Emotional Factors in the Design of Eldercare Technologies." *Conference on Universal Usability*, 2000, Washington DC, pp. 72-80.
- [8] IDEO Product Development, Kiss Communicator and Heart2Heart conceptual design projects.
<http://www.ideo.com>
- [9] Ishii, H. and Ullmer, B., Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms, in *Proceedings of Conference on Human Factors in Computing Systems* pp. 234-241, 1997.
- [10] Lombard, M. and Ditton, T. "At the Heart of It All: The Concept of Presence." *Journal of Computer Mediated Communication* 3, (2), September 1997.
Available online at
<http://www.ascusc.org/jcmc/vol3/issue2/lombard.html>
- [11] Mattelmäki, T and Keinonen, T: Design for Brawling -Exploring Emotional Issues for Concept Design, in *Proceedings of The International Conference on Affective Human Factors Design*, 2001.
- [12] Mynatt, E. D., and Rogers, W. A. Developing technology to support the functional independence of older adults. *Ageing International*, Vol 27, pp. 24-41.2002.
- [13] Paulos, E. and Canny, J. "Ubiquitous Tele-embodiment Applications and Implications", Special Issue on Innovative Applications of the World Wide Web, *International Journal of Human-Computer Studies*, 1997.
- [14] Redström, R., Skog, T., Hallnäs, L., Informative art: Using amplified artworks as information displays, in *Proceedings of DARE 2000 on Designing Augmented Reality Environments*, pp.103-114, 2000
- [15] Shibata, T., Tashima, T., Arao, M., and Tanie, K. Interpretation in Physical Interaction between Human and Artificial Emotion Creature in *Proceedings of the International Workshop on Robots and Human Interactive Communication*, 1999.
- [16] Social Media Group, MIT Media Laboratory,
<http://smg.media.mit.edu>
- [17] Strong, R., and W. Gaver. Feather, Scent, and Shaker: Supporting Simple Intimacy in *Proceedings of CSCW '96*, pp.29-30, 1996.
- [18] Tsumaki, Y. et al. "Telecommunicator: A Novel Robot System for Human Communications." *Proceedings of the International Workshop on Robots and Human Interactive Communication*. IEEE September 2002.
- [19] Weiser, M., and Brown, J.S., *Designing Calm Technology*. December 21, 1995,
Available online at
<http://www.ubiq.com/weiser/calmtech/calmtech.htm>